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(54) **ELECTRON TUBE**

(57)Abstract:

PROBLEM TO BE SOLVED: To provide an electron tube such as klystron, X-ray tube and the like which have high efficiency.

SOLUTION: In this electron tube that enables an electron beam produced between a cathode and an anode to have a collector electrode for capturing electrons that pass through the anode, the anode is formed thin to the extent that electrons can be transmitted there through.

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CLAIMS

[Claim(s)]

[Claim 1] The electron tube characterized by coming to form said anode plate thinly possible [transparency] in said electron in the electron tube which has cathode, the anode plate through which the electron picked out from this cathode passes, and the collector electrode which catches the electron which passed through this anode plate.

[Claim 2] The electron tube according to claim 1 characterized by making potential of said collector electrode into a value lower than said anode plate.

[Claim 3] Said anode plate is the electron tube according to claim 2 characterized by an X-ray occurring, when it serves as a target and said electron beam collides with this anode plate.

[Claim 4] The thickness of said anode plate and the acceleration voltage of the electron impressed to this anode plate are the electron tube according to claim 3 characterized by being set as the value from which the kinetic energy of the electron which penetrated said anode plate is set to 10 or more keVs.

[Claim 5] At least one layer is the electron tube according to claim 3 or 4 which said anode plate has multilayer structure, and a surface at least is a metal layer which contributes to generating of an X-ray, and is characterized by being other metal layers with a high mechanical strength with a consistency lower than said metal layer.

[Claim 6] For said electron, the collector electrode of all the stages come to carry out two or more step parallel connection, and excluding the collector electrode of the last stage at least is [said collector electrode] the electron tube according to claim 3 or 4 with which it is characterized by being formed thinly possible [transparency].

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to what has improved the energy utilization effectiveness of an electron beam especially about the electron tube which has the collector electrode which catches cathode, the anode plate which passes an electron, and its electron.

[0002]

[Description of the Prior Art] Conventionally, this kind of electron tube maintains the inside of a bulb at the condition near the so-called vacuum with a small degree of vacuum, it accelerates with the electrical potential difference which impressed the electron picked out from cathode to the anode plate, and it forms an electron beam, uses that kinetic energy etc., and is giving the predetermined function.

[0003] For example, in the case of a klystron, the electron beam passes an input cavity resonator and an output cavity resonator, and is caught by the collector electrode. While reaching a collector electrode from cathode, this electron beam can apply density modulation according to the frequency of the microwave inputted into the input cavity resonator, and in case it passes an output cavity resonator, it carries out induction of the microwave to an output cavity resonator. Thus, a klystron operates as the amplifier tube of microwave.

[0004] On the other hand, although it is the same electron tube, there is an X-ray tube without the above structures. Although an X-ray tube is a vacuum pipe of structure which an electron beam is made to collide with the anode plate target which rotated [fixed], and emits an X-ray, the actual condition is that the max of the kinetic energy which an electron beam has is also convertible for the energy of an X-ray only about 1%. Then, the X-ray tube in the case of obtaining an X-ray with high reinforcement has the common thing of structure which obtains the X-ray of high intensity by [as enlarging the heat capacity of the anode plate where an electron beam is irradiated, and moving the part which is made to rotate an anode plate, and by which an electron beam is irradiated and heat distribution's becoming homogeneity] with the electron beam of a high current.

[0005]

[Problem(s) to be Solved by the Invention] At the above klystrons, since the interaction with the high frequency electric field at the time of an electron beam passing a cavity resonator was performed by the high frequency electric field of the resonator overflowing into the drift space through which an electron beam passes, it had the case where it became imperfection, by part for the core of an electron beam.

[0006] Moreover, the above X-ray tubes had the trouble of consuming large power, in order to obtain the X-ray of high intensity.

[0007] This invention aims at canceling the above-mentioned trouble and offering the electron tube with sufficient energy efficiency.

[0008]

[Means for Solving the Problem] In order to attain the above-mentioned object, this invention is characterized by coming to form said anode plate thinly possible [transparency] in said electron in the electron tube which has cathode, the anode plate through which the electron picked out from this cathode passes, and the collector electrode which catches the electron which passed through this anode plate. By this configuration, the electron tube with sufficient energy utilization effectiveness of an electron beam is obtained.

[0009] Moreover, it is characterized by making potential of a collector electrode into a value lower than an anode plate. Thereby, since an electron beam is caught by the electrical potential difference lower than the electrical potential difference of an anode plate at a collector electrode, the electron tube with sufficient energy utilization effectiveness of an electron beam is obtained.

[0010] Moreover, said anode plate is made to serve as a target, and since the energy of the electron beam consumed in an anode plate is reduced with constituting so that an X-ray may occur by making said electron beam collide with this anode plate, an X-ray tube with the very sufficient energy utilization effectiveness of an electron beam is obtained.

[0011] Moreover, in such an X-ray tube, by considering as the configuration which sets the thickness of said anode plate, and the acceleration voltage of the electron impressed to this anode plate as the value from which the kinetic energy of the electron which penetrated said anode plate is set to 10 or more keVs, an X-ray with a wavelength of 1A or less can be generated, and sufficient matter penetrability force for an X-ray can be given.

[0012] Moreover, it is making the anode plate of said X-ray tube into multilayer structure, and making it at least the metal layer which a surface contributes to generating of an X-ray at other metal layers with a low consistency and at least one layer higher [a mechanical strength] than said metal layer. X-ray generating effectiveness, such as a tungsten and copper, -- being high (a consistency being high) -- even if a mechanical strength uses the low matter for an anode plate and forms this thinly, the matter with the low consistency of other layers and a high mechanical strength can be

made to be able to support, and mechanical strength can be maintained.

[0013] Moreover, two or more steps of collector electrodes of said X-ray tube are prepared, parallel connection of these is carried out electrically, and at least, an electronic energy recovery is performed smoothly and can improve effectiveness rather than one step because said electron forms thinly the collector electrode of all the stages except the collector electrode of the last stage possible [transparency].

[0014]

[Embodiment of the Invention] Drawing 1 is drawing showing the gestalt of operation of this invention, and shows the example of a klystron. As for 1, as for cathode, 2a, and 2b, in this Fig., an input and an output cavity resonator, and 3 are metal membranes which penetrate the electron with which a collector electrode and 4 constitute a heater and 21, 22, 23, and 24 constitute an anode plate 2, respectively.

[0015] As shown in this Fig., input cavity resonator 2a and output cavity resonator 2b serve as an anode plate by same electric potential, and the seal of approval of the plate voltage Va is carried out between cathode 1. An electron is accelerated with this electrical potential difference, and the metal membranes 21, 22, 23, and 24 formed by titanium with a thickness of 5 micrometers are penetrated. The electron which penetrated the metal membrane is caught by the collector electrode 3 with collector voltage Vc. In that case, if Vc is smaller than Va, the kinetic energy of the part electron can be collected and energy efficiency will become good.

[0016] As for the metal membranes 21, 22, 23, and 24 of cavity resonator 2a and 2b, having been conventionally formed in a metal mesh was common. Although the high frequency electric field were made from the resonator of a klystron by parallel in the direction which an electron beam penetrates, when it formed in a mesh, a metal and space existed by turns, and since high frequency electric field were jutted out of the metal part, they were not parallel thoroughly with an electron beam. However, if this invention is used, it will be formed so that the high frequency electric field between the metal membranes which faced each other may become an electron beam and parallel thoroughly. For this reason, the interaction of an electron beam and RF electric field comes to be performed efficiently.

[0017] Drawing 2 is drawing showing the gestalt of other operations of this invention, in this Fig., a corresponding thing is shown and 2 is that the thing of the same sign as drawing 1 is the same, or the anode plate in which the electron was formed thinly possible [transparency]. Drawing 3 is drawing showing the structure of the cross section of the anode plate used for drawing 2 , 5 is a tungsten layer and 6 is a titanium layer.

[0018] An electron is irradiated into an electron by plate voltage Va=100kV from cathode 1 in ejection and an anode plate 2. The anode plate 2 has the two-layer structure of the tungsten layer 5 and the titanium layer 6, as shown in drawing 3 , and each thickness t1 and t2 to the travelling

direction of an electron beam is t1=5micrometer and t2=10micrometer. An electron collides with the tungsten which constitutes an anode plate, is slowed down, and emits an X-ray. Since an anode plate is very as thin as tungsten 5micrometer and titanium 10micrometer, an electron beam penetrates an anode plate 2 and results in a collector electrode.

[0019] When incidence is carried out to the solid-state of a consistency rho and thickness t with an impingement rate V0, the rate V of the electron at the time of escaping from a solid-state is given by V4=V04-CTxrhoxt. CT is a constant and is CT=5.05x1033 (m6kg-1s-4) here.

[0020] When the rate of the electron which penetrated the anode plate 2 in the gestalt of this operation is found from this relational expression, it turns out that it becomes a rate equivalent to the energy of 11keV. Energy at this rate is collected by impressing electrical-potential-difference VC=10kV to a collector electrode.

[0021] With the X-ray tube which a high-speed electron is made to collide with an anode plate, and is made to generate an X-ray, the generating effectiveness of an X-ray is usually about 1%, and even if the thickness of an anode plate is thick, the yield of an X-ray does not change. Therefore, conventionally, although the same X dosage is obtained, the energy of 10keV(s) is collected for the place for which the energy of 100keV(s) was required by the collector electrode, and effectiveness lifting of about ten percent is achieved.

[0022] Although the gestalt of this operation showed the case where the number of collector electrodes was one, even if it uses a collector electrode as multistage, actuation is the same and can form an efficient X-ray tube. For example, as shown in drawing 4 , a collector electrode is constituted in two steps, 3a and 3b, collector voltage Vc1 and Vc2 is given to these, respectively, and parallel connection is electrically carried out to them. Under the present circumstances, the electron forms thinly possible [transparency] like the anode plate which mentioned above other collector-electrode 3a except for collector-electrode 3b of the last stage. Thus, it is possible for an electronic energy recovery to be smoothly performed by using a collector electrode as multistage, and to constitute an efficient bulb from one step.

[0023] The X-ray by the side of long wavelength, i.e., low energy, is emitted from the X-ray of the wavelength corresponding to the acceleration voltage of an anode plate in an X-ray tube. This is because an X-ray is emitted by the electron to which the electron was slowed down by the anode plate and energy fell inside the anode plate by it. The X-ray changes in the permeability of the matter with the wavelength, and permeability becomes it small extremely that wavelength is 1A or more. By 1A or more, i.e., energy, by about 10 or less keVs, a loss is large and capacity as an X-ray tube cannot demonstrate [wavelength of an X-ray] enough. Therefore, it is effective for the effectiveness rise of an X-ray tube by making an anode plate penetrate, before electronic kinetic energy is set to 10 or less keVs, not generating the X-ray below the energy, and collecting energy with collector voltage. In addition, plate voltage is not exceeded, although it is better as electronic kinetic energy is high.

[0024] It is more advantageous to use a metal with a high consistency for an anode plate, in order to gather the effectiveness of X-ray generating. However, the thickness which can penetrate an electron only with a metal with a high consistency becomes extremely thin, and a mechanical strength falls and is inconvenient. Then, this fault is canceled by making it the structure which piled up the tungsten layer for generating an X-ray, and the metal layer of the low consistency which maintains a mechanical strength.

[0025] Titanium, a graphite, etc. are effective as a metal of the low consistency which maintains a tungsten, copper, and a mechanical strength as a metal for generating an X-ray. Moreover, although this operation gestalt showed the case where the anode plate was being fixed, it is also possible to rotate an anode plate like the conventional X-ray tube, and to make heat distribution of an anode plate into homogeneity.

[0026]

[Effect of the Invention] If this invention is used for the electron tube which has cathode, the anode plate through which an electron passes, and the collector electrode which catches the passed electron as explained above, energy efficiency can be made better than before.

[0027] Make extent which an electron penetrates especially serve as a target to the anode plate made thin, and an X-ray is generated. By arranging the collector electrode which catches the transmitted electron and impressing the electrical potential difference which makes small kinetic energy of soft landing, i.e., an electron, and catches an electron to a collector electrode to a collector electrode Since the kinetic energy of the electron which penetrated the anode plate which did not contribute to generating of an X-ray is recoverable, the X-ray tube with which the energy efficiency of X-ray generating has been improved can be offered.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is drawing showing the gestalt of operation of this invention.

[Drawing 2] It is drawing showing other operation gestalten of this invention.

[Drawing 3] It is drawing which expanded the anode plate of drawing 2 .

[Drawing 4] It is drawing showing the operation gestalt of further others of this invention.

[Description of Notations]

1: Cathode, 2:anode plate, a 2a:input cavity resonator, 2b:output cavity resonator, 3 and 3a, a 3b:collector electrode, 4:heater, 5:tungsten layer, 6:titanium layer, 21, 22, 23, 24 : metal membrane

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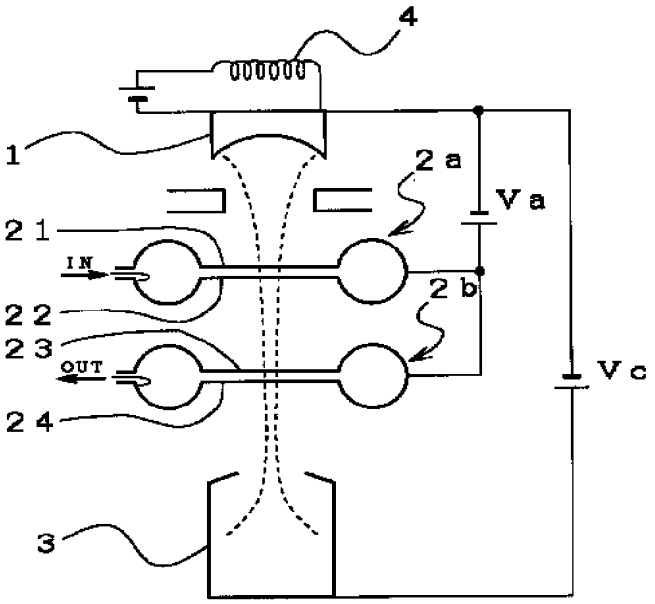
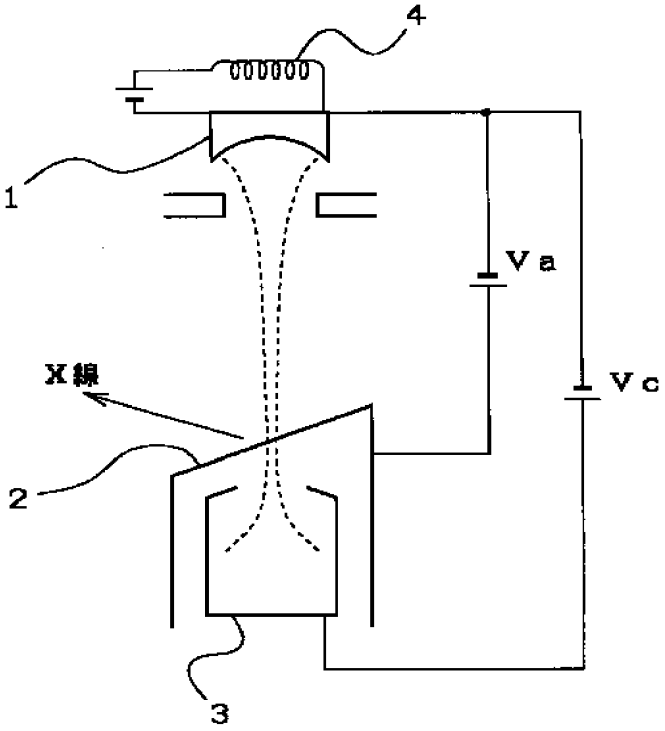
[Translation done.]

DRAWINGS

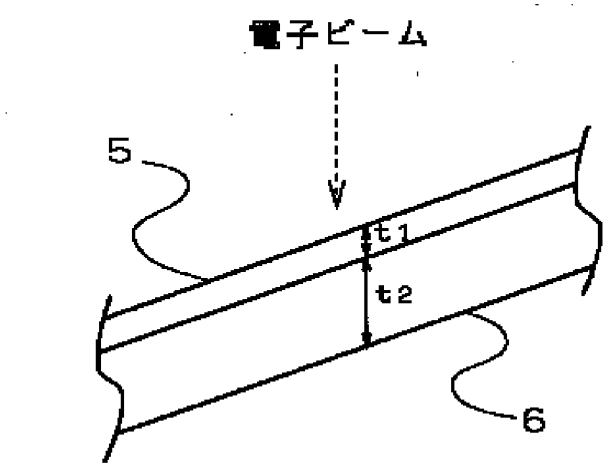
[Drawing 1]



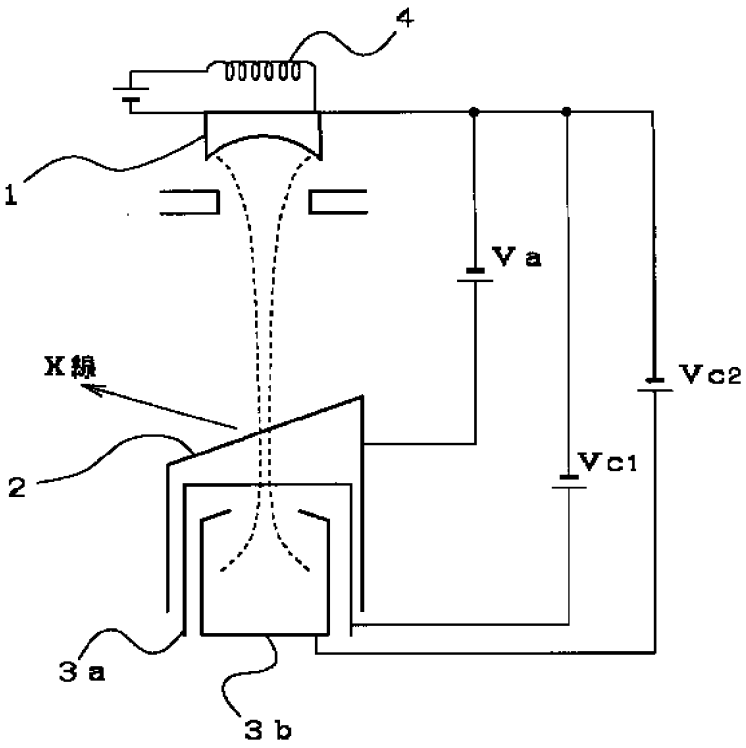
[Drawing 2]



[Drawing 3]



[Drawing 4]



[Translation done.]